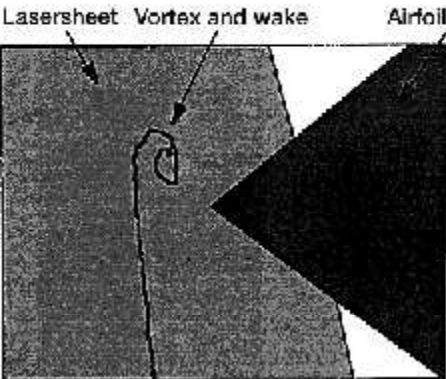




Laser Sheet Flow Visualization Developed for Lewis' Icing Research Tunnel



Laser sheet image (top) of wing tip vortex from IRT and description of laser sheet image (bottom).

A new flow-visualization technique has been developed for use in the NASA Lewis Research Center's Icing Research Tunnel (IRT). This technique uses a sheet of light shining across the wind tunnel to illuminate a mist of water droplets in the air and display any organized flow patterns. Since the IRT already has the special water spray system required for aircraft icing experiments, no special visualization seeding material is required. The system has been used to visualize the changes in tip and leading edge vortices caused by ice accretion. Because the IRT's icing spray is used as part of the visualization technique, changes in the flow patterns about a wing can be observed and measured during the ice accretion process.

A 15-W argon-ion laser coupled with sheet-generating optics allows flow to be visualized in the IRT. Fiber-optic cables transport light from the remotely located laser into the tunnel test section. The laser rests on a vibration isolation table that floats on a layer of air. The intensity of the light is controlled by a local controller, and the laser is cooled by circulating water. An optical box made of wavelength-limiting tinted acrylic material is attached to the laser housing. This filtered Plexiglas allows observers to see the optics inside the box, but not the laser beam itself. The box has an interlocked hinged top so that only qualified operators can open it to align the laser.

The sheet-generating optics allow the thickness and the fanning of the sheet to be controlled very easily. The optics are mounted on remotely controlled traverses to aid in positioning the laser sheet in the test section.

Cameras can be placed on up to three sides of the tunnel test section to record flow-visualization images. The most common views are an overhead view and a side view of the model. Because both areas have exposed laser light, they are isolated from nonqualified personnel with interlocks. The windows to the IRT control room are covered with wavelength-limiting, tinted acrylic material to protect the tunnel operators and researchers from the laser light. High-speed, low-light digital cameras, low-light video cameras, 35-mm cameras, and intensified, digital still cameras are used to image the flow. For most tests, the laser power is limited to 3 to 4 W to prevent blooming in the imaging.

As just mentioned, the IRT's spray system generates the seed for the flow visualization. The most commonly used spray condition was selected to produce frozen ice particles in

the 10- to 15-micrometer range. This spray condition is used because the resultant particles do not produce any significant ice accretion on the model.

The photograph and drawing depict the wing tip vortex and wake produced by a swept-wing model. The dark bands correspond to regions where the water droplets have been swept away by the vortex or wake. The bright regions correspond to areas where the water droplets have accumulated.